MSP Antenna for RADAR with Bandwidth and Gain Enhancement

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***Abstract*— The proposed antenna analyzes the triband MSP antenna for RADAR. Firstly, a rectangular MSP antenna having four rectangular slots is designed in order to obtain dual band frequencies. A cylindrical slot is etched on a patch to get a triple band. A rectangular DGS is utilized for enhancing the gain and the bandwidth. The proposed antenna is being designed on a FR4 epoxy substrate having a dielectric constant of 4.9 and thickness of 1.8 mm. The size of the designed antenna is 14 x 14 x 1.87 mm3 . The parameters of the proposed MSP antenna like gain and bandwidth are analyzed using HFSS. The proposed antenna is less complex in structure and hence requires less space. These parameters of the antenna make it applicable for practical applications.**

***Index Terms*—MSP (Microstrip Patch), RADAR (Radio Detection and Ranging), DGS (Defective Ground Structure)**

I. INTRODUCTION

Detection of distant objects like ships or air craft by radar or measuring device during which the echo of a pulse of microwave radiation is employed to notice and find distant objects is understood as radio detection and ranging system. Basics of RADAR are to find an object by measuring the characteristics of received radio waves. Because the market of miniature wireless devices is quickly increasing, the antenna engineers showed interest in MSP [2]. Microstrip antennas has varied engaging options like low in profile, straightforward for production, compact in structure, light in weight, conformable to the hosting surfaces, and similar temperament for integration with the electronic system [3] .

MSP antenna consists of an awfully thin metallic strip cut on a grounded material substrate [4]. For reducing the dimensions of the microstrip antenna and in order to overcome its limitation of low impedance gain and bandwidth, several ways are commonly planned and investigated by using: cavities [5], irises [6], rolled structures [7], multilayer [8]. In the following years, lots of novel DGS were planned and they had become one in every of the foremost attention-grabbing areas of research due to their in depth relevancy in microwave circuits [9]. RADAR is used in wide range of business, military, medicine and conjointly in cellular telecommunication via base station.

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In this paper, a replacement triband antenna is intended for RADAR making use of DGS. For providing feed in this MSP antenna we make use of a microstrip line feeding technique. Slots on patch are accountable for the excitation of the multi resonant mode and for higher performance we have to cut rectangular form in ground plane. In this paper in section II the MSP structure with four rectangular slots and one cylindrical slot and DGS based mostly on MSP antenna is explained. In section III simulation results are discussed and the graphs of return loss, radiation pattern at three different frequencies and 3D polar plot of gain is discussed. Then finally we'll conclude the essential advantages in the conclusion portion.

II. ANTENNA DESIGN

The antenna is designed on FR-4 epoxy substrate that has dielectric constant of 4.9 and thickness of 1.8 mm. Copper material is employed for ground plane and patch with thickness of 0.035 mm. Microstrip feeding is provided for the designed MSP antenna.

A. MSP Antenna with Four Rectangular Slots

In order to obtain better results, four rectangular slots are being etched on the patch as S1, S2, S3 and S4. Slots S1 and S2 are of same length T1 and same width A. The vertical slots S3 and S4 are of same length T and same width A as shown in Figure 1.

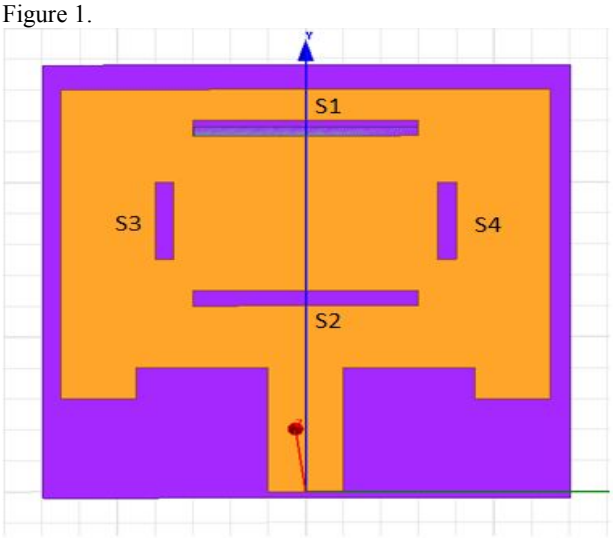


Figure 1: MSP Antenna with Four Rectangular Slots.

B. MSP Antenna with Cylindrical Slot

A cylindrical slot is cut in a patch taking outer radius as R1 and inner radius as R2 as shown in Figure 2. By using a cylindrical slot along with four rectangular slots a very sharp and enhanced return loss is obtained when compared with result of MSP antenna only with four rectangular slots. The comparison results of MSP antenna with only four rectangular slots and with four rectangular slots and one cylindrical slot is as shown in Figure 4.

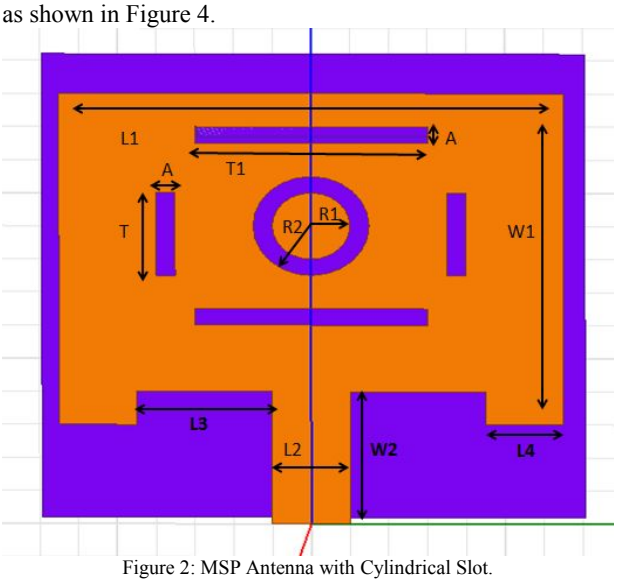


Figure 2: MSP Antenna with Cylindrical Slot.

C. MSP Antenna with DGS

For improving gain and bandwidth a rectangular portion from a ground plane is cut which is of length B1 and width B2 with the previously designed MSP antenna. The modified MSP antenna with DGS is as shown in Figure 3. The result of MSP antenna with four rectangular slots, one cylindrical slot and DGS is as shown in Figure 5. The dimensions of the proposed antenna are as shown in TABLE I.

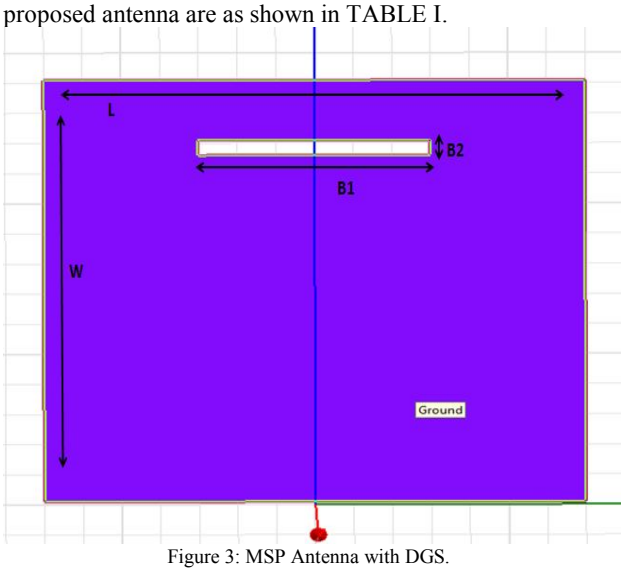


Figure 3: MSP Antenna with DGS.

TABLE I
DIMENSIONS OF PROPOSED MSP ANTENNA.

Antenna Parameter	Value (mm)	Antenna Parameter	Value (mm)
L	14	W	14
L1	13	W1	10
L2	2	W2	4
L3	3.5	L4	2
T	2.5	A	0.5
T1	6	R1	1
R2	1.5	B1	6
B2	0.5		

III. RESULTS AND DISCUSSIONS

The graphs, radiation pattern and the 3D polar plot for gain of the simple rectangular MSP antenna, with four rectangular slots, one cylindrical slot and with DGS are described in this section. The proposed antenna is simulated by the help of the EM simulation software.

A. Return Loss

Figure 4 shows the return loss of the MSP antenna with four rectangular slots in comparison with MSP antenna with four rectangular slots and one cylindrical slot. Figure 5 shows the return loss of MSP antenna with DGS. The comparison of different parameters of MSP antenna is listed in TABLE II.

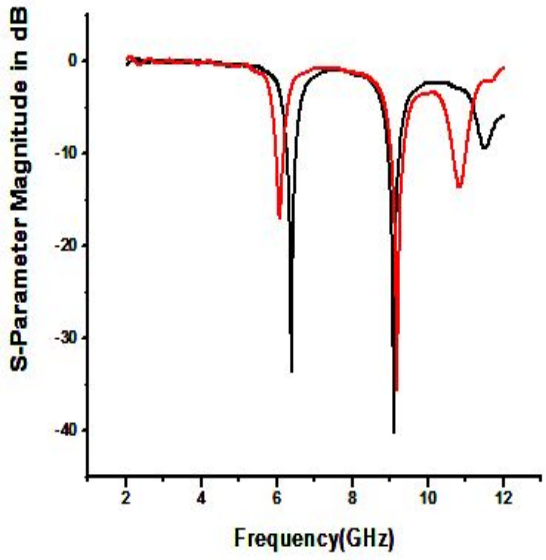


Figure 4: Return Loss of MSP Antenna with and without Cylindrical Slot.

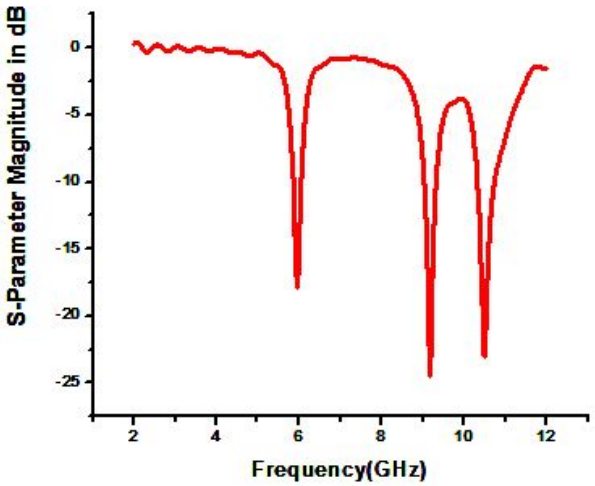


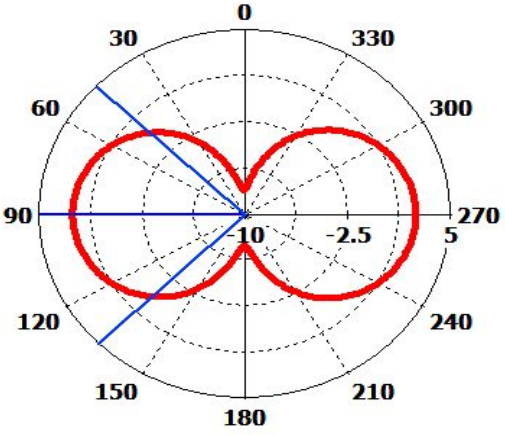
Figure 5: Return Loss of MSP Antenna with DGS.

TABLE II
The comparison of different parameters of MSP antenna

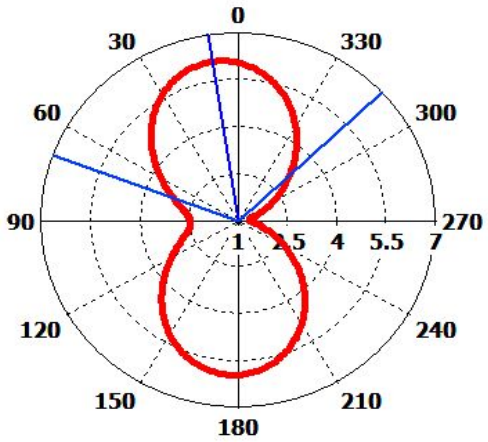
Parameters	Gain(dBi)	Bandwidth(GHz)
Without DGS Resonant Frequencies(GHz)		
5.9	2.3	0.18
9.1	5.8	0.30
10.4	4.6	0.308
With DGS Resonant Frequencies(GHz)		
5.9	2.5	0.19
9.1	6.1	0.32
10.4	5.3	0.39

B. Radiation Pattern

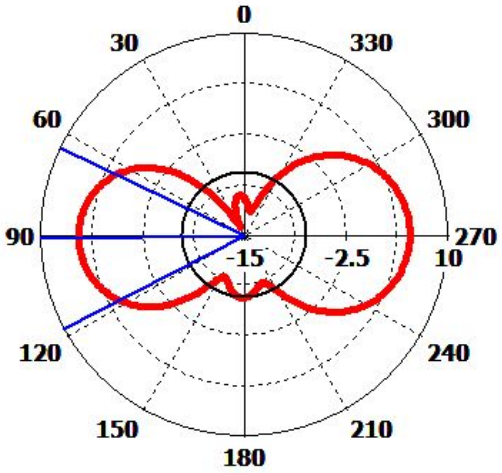
The radiation pattern referred to directional dependence of the strength of fields from the antenna. The far field gain Abs radiation pattern of proposed antenna at all resonant frequencies is shown in Figure 6. Gain, bandwidth and percentage bandwidth of proposed MSP antenna are improved using DGS structure but the efficiency is decreased by using the DGS. As we are getting lots of advantages using DGS structure so we have to compromise with efficiency of antenna.



(a)



(b)



(c)

Figure 6: Radiation pattern of MSP Antenna at (a) 5.9GHz, (b) 9.1GHz, (c) 10.4GHz.

C. Gain

The gain of the MSP antenna with DGS is enhanced when compared to MSP antenna without DGS and this is discussed in TABLE II. Hence this proposed antenna can be used in RADAR applications. The 3D polar plot of gain at 9.1GHz is as shown in Figure 7.

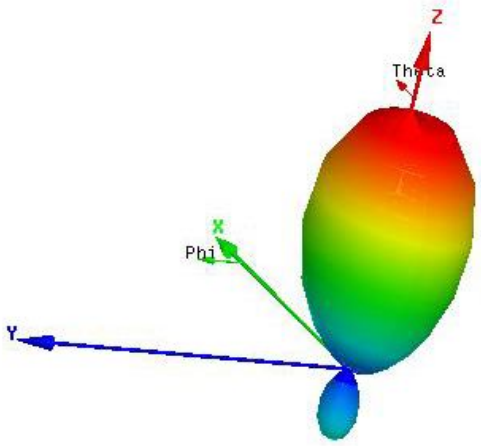


Figure 7: 3D Polar Plot of gain of MSP Antenna at 9.1GHz.

IV. CONCLUSION

The proposed antenna is less complex in size with dimension 14 X 14 X 1.87 mm^3. MSP antenna with four rectangular slots and one cylindrical slot is designed. Thus for improving its gain, directivity and bandwidth we cut a rectangular slot from its ground plane which is called a DGS structure then the gain is improved to 2.5, 6.1 and 5.3dBi from 2.3, 5.8 and 4.6dBi respectively. In future, the proposed antenna can be converted into reconfigurable MSP antenna using RF switches, so that single antenna can be used for multiple frequencies.

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